

REMARKS

Claims 1-12, 23-32, 35 and 36 are pending in the application.

Claims 1-12, 23-32, 35 and 36 are rejected.

Claim Objections

Claim 24 has been objected to as follows:

4. Claim 24 is objected to because of the following informalities: Since the Applicant has omitted steps "(a) and (b)" from claim 23, step "(c)" should be omitted from claim 24 as well. Please note that the Examiner is not referring to the contents or the limitations of the steps, but the symbols, which represent the steps. Appropriate correction is required.

Claim 24 has been amended as suggested by the examiner and is deemed to satisfy all of the requirements of the Patent Statute. Reconsideration and withdrawal of this objection is therefore requested.

Claim Rejections - 35 USC § 103

Claims 1-10 and 30-31 have been rejected as follows. This rejection is traversed.

6. Claims 1-10 and 30-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Carlson (U.S. Pat. #4,554,585) in view of Hsieh et al. (U.S. Pat. #6,798,923). The rejection stated:

"For claim 1, Carlson teaches an electronic imaging system (fig. 1, 100, 110, 108) for capturing an image of a scene (col. 2, lines 57-62), said imaging system comprising:

"(a) an optical system (fig. 1, 100) for producing an optical image of the scene (col. 2, line 63 - col. 3, line 10);

"(b) an imaging sensor (solid-state imager, col. 2, lines 63-65) having a surface in optical communication (col. 2, line 66 - col. 3, line 2) with the optical system; and

"(c) a plurality of imaging elements (fig. 2a) distributed on the surface of the imaging sensor (col. 4, lines 13-23), said imaging elements converting the optical image into a corresponding output image (fig. 1, ref. 106; col. 3, lines 4-7), said imaging elements being located according to a distribution

representable by a nonlinear function in which the relative density of the distributed imaging elements is greater toward the center of the sensor (col. 4, lines 28-33), wherein the distribution provides physical coordinates for each of the imaging elements corresponding to a projection of the scene onto a non-planar surface (col. 4, lines 24-28); wherein said output image has a plurality of pixels (inherently - CCD; col. 2, line 63 - col. 3, line 7), each said pixel corresponding to a respective one of said imaging elements (col. 4, lines 13-23);

"wherein said optical system provides a perspective (wide field of view) projection of said optical image onto said surface (col. 2, line 63 - col. 3, line 7), said optical image produced by the optical system has a distortion relative to the surface of the imaging sensor and the distribution of imaging elements on that surface compensates for the distortion such that said output image is free of said distortion and has said pixels in a uniform rectilinear array. Please read Carlson's Abstract, col. 4, lines 24-28, and col. 5, line 14 - col. 6, line 9.

"However, Carlson does not expressly teach that wherein said optical image has a perspective distortion relative to said surface, said perspective distortion being inherent in geometry of said perspective projection onto said surface, and said distribution of said imaging elements on said surface of said imaging sensor compensates said output image for said perspective distortion, such that said output image is free of said perspective distortion.

"In a similar field of endeavor Hsieh teaches that said optical image has a perspective distortion relative to said surface (col. 3, line 64 - col. 4, line 1), said perspective distortion being inherent in geometry of said perspective projection onto said surface (col. 3, line 64 - col. 4, line 3), and said distribution of said imaging elements on said surface of said imaging sensor compensates said output image for said perspective distortion, such that said output image is free of said perspective distortion and has said pixels in a uniform rectilinear array (col. 3, line 64 - col. 4,

line 40). In light of the teaching of Hsieh, it would have been obvious to one of ordinary skill in the art at the time the invention was made for Carlson to implement a system which corrects perspective distortion in order to permit a predetermined mapping of the image onto the sensor."

Applicant challenges these interpretations of the teachings of Carlson and Hsieh. Carlson teaches the use of:

"low-pass prefilter 308 includes a diffusing surface 310 situated in spaced relation with respect to the pattern of picture elements 306 of imager 300, with the spacing distance between diffusing surface 310 and each picture element 306 of the pattern increasing as a direct function of the size of that picture element."
(Carlson, Col. 5, lines 34-40)

The invention defined by the claims does not use a prefilter for such purposes. Moreover, Carlson further teaches that:

"each discrete picture element 200, regardless of its position on the imager, occupies the same angular extent. However, the radial extent of each discrete picture element 200 increases substantially linearly from the high-resolution central region 202 of the spatial distribution pattern to the low-resolution periphery 204 of the spatial distribution pattern." (Carlson, Col. 4, lines 24-33).

Whereas the picture elements of Carlson vary in size from the central region to the periphery, as illustrated in Fig. 5 of the present application, all of the picture elements of the claimed invention are of the same size and do not vary in size

Further, Carlson's imaging system is not addressed rectilinearly as in the claimed invention. In fact, each radial band shown in Fig. 2a of Carlson contains the same number of samples. Each sample comprises the "same angular extent" (Carlson, Col. 4, line 28). In a system, as in the claimed invention, that addresses sensor positions rectilinearly, each sample will not comprise the same angular extent.

Contrary to the assertion by the examiner, Hsieh does not teach that "said distribution of said imaging elements on said surface of said imaging sensor compensates said output image for said perspective distortion, such that said

output image is free of said perspective distortion.” Whereas in the claimed invention, the image output from the image sensor is free of perspective distortion due to the unique pattern of imaging elements of the sensor, in Hsieh, the image output from the sensor is not free of perspective distortion. Rather, in Hsieh, an extra processing step is required in software to resample the image output from the sensor onto a rectilinear grid.

“In general, it is difficult to seamlessly stitch two adjacent images together to form a panoramic image due to perspective distortion introduced by a camera. To remove the effects of this distortion, these images are preferably reprojected onto a simple geometry, e. g., a cube, a cylinder, or a sphere. -----Based on Eqs. (3) and (4), input images {from the sensor} are provided and then (step 10) warped into a cylindrical map for further registration to construct a complete panoramic scene(step 11) (Hsieh, Col. 3, line 66 – Col. 4, line 39).

“Referring to Fig.8, one preferred architecture for implementing the real-time stitcher apparatus, described above, includes input devices 60(e. g., digital cameras or scanners) to acquire a series of panoramic images. Then, the panoramic images are stored into external storage 62 such as hard disks for further processing or being directly provided to one or more microprocessors 64 for stitching. the microprocessors 64 perform stitching including warping ---”(Hsieh, Col. 10, line 64 – Col. 11, line 4)

There is no disclosure in Hsieh of correction for perspective distortion through the pattern of imaging elements. The image input devices 60, such as digital cameras or digital scanners, provide images from conventional image sensors that have equally sized sensor elements which are arrayed in a rectangular pattern on the image sensor. Any correction for perspective distortion is carried out in microprocessors 64, in the warping step by digital image processing. .This extra step is expensive and time consuming and not required by the claimed invention. Clearly, the claimed invention is advantageous, novel and nonobvious over the cited combination of Carlson and Hsieh and should be allowed.

The arguments presented above relative to claim 1 are equally applicable to Claims 2-10 which are dependent from Claim 1 and also to Claims 30-31. These claims are also clearly novel and nonobvious over Carlson and Hsieh and should be allowed.

Claims 11-12, 32, 35-36 have been rejected as follows. This rejection is traversed.

7. Claims 11-12, 32, and 35-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Carlson (U.S. Pat. #4,554,585) in view of Hsieh et al. (U.S. Pat. #6,798,923) as applied to claims 10 and 30 above, and further in view of Ribera et al. (U.S. Pat. # 6,603,503). The rejection stated:

"For claim 11, Carlson, as modified by Hsieh, discloses a system with a moveable television camera that produces a video signal, which is coupled to an image signal processor. Carlson's image signal processor, which analyzes the image defined by the video signal to determine the exact whereabouts of a particular object in field of view, can inherently operate directly on the output signal without having to warp the image data (Carlson, col. 3, lines 33-46).

"However, Carlson does not expressly teach a system including a processor for combining the images into a composite image.

"In the same field of endeavor, Ribera discloses a system including a processor (Ribera, fig. 4, ref. 10) for combining the images into a composite image, thereby the processor can operate directly on the output signal without having to warp the image data (Ribera, col. 6, lines 10-21 and col. 4, lines 51-55). Similar to Ribera, Carlson's invention is related to wide view images (Carlson, col. 2, line 67 - col. 3, line 1). In light of the teaching of Ribera, it would have been obvious to one of ordinary skill in the art at the time the invention was made for Carlson to implement a system including a processor for combining the images into a composite image, thereby the processor can operate directly on the output signal without having to warp the image data in order to

display panoramic images over a substantially 360 degree by 360 degree range of angles (Ribera, col. 1, lines 36-39)."

The arguments presented above relative to Carlson and Hsieh are equally applicable to this rejection and will not be repeated here. In addition, Carlson states

"In accordance with the principles of the present invention, relatively high spatial resolution is provided solely within the limited extent of the central region 104 of field of view 102. Within these portions of the field of view 102 falling outside of central region 104 only relatively low spatial resolution is provided." (Carlson, Col. 3, lines 56-61)

A composite of Carlson's images would have a series of high resolution spots/lines alternating with areas of low resolution. The usefulness of such a composite image is not apparent, particularly in view of the intent of the imaging system of Carlson to be part of a larger control system. (Carlson, Col. 2, lines 57-60). Such a composite image would also contradict Carlson's goal of reduced signal processing. (Carlson, Col.3, lines 61-65).

Ribera discloses:

"A spherical lens and spherical charge-coupled device ("CCD") detects live 3-D panoramic images. Image and positioning sweep generators are adapted to process the detected, 3-D images and to generate a novel video signal." (Ribera, Abstract)

Ribera has nothing to do with the present invention. Whereas in the claimed invention, perspective distortion is corrected by using a novel and inventive distribution of imaging elements on a planar surface, Ribera discloses the use of a spherical lens and non-planar spherical CCD to capture 3-D images. There is no suggestion in Ribera of the desirability of correcting for perspective distortion in combined images. Rather in Ribera the purpose is to combine images to produce a 3-D effect. Clearly the rejected claims are novel and nonobvious over Carlson, Hsieh and Ribera.

Claims 23-29 have been rejected as follows. This rejection is traversed.

8. Claims 23-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Carlson (U.S. Pat. #4,554,585) in view of Hsieh et al. (U.S. Pat. #6,798,923) and Huang et al. ("Panoramic Stereo imaging System with Automatic Disparity Warping and Seaming," Graphical Models and image Processing, Vol. 60, No. 3, May 1998, pp. 196-208.)

The arguments presented above relating to the non-applicability of Carlson and Hsieh to the rejected claims is also relevant here and will not be repeated.

Huang is cited as follows:

"In the same field of endeavor, Huang teaches a method of generating a composite digital image from at least two source optical images (page 197, section 3.1, paragraph 1) having perspective distortion relative to a planar surface, said method comprising: (b) combining the source digital images to form a composite digital image (page 200, section 3.5). Additionally, Huang's panoramic stereo imaging system inherently has an imaging sensor because his system includes two cameras for the left-eye and the right-eye (page 197, section 3.1, paragraph 2). This system generates focused images by selecting the correctly focused image for each sensor (pages 197-198, section 3.2, paragraphs 1-2). Please see figs. 5-6 and read pages 199-200, section 3.4, paragraphs 1-2. Similar to Huang, Carlson discloses an imaging system for image warping/ blurring improvements (Carlson, Abstract). In light of the teaching of Huang, it would have been obvious to one of ordinary skill in the art at the time the invention was made for Carlson to provide a method of generating a composite digital image from at least two source digital images in order to provide 360° panoramic stereo images (Huang, section 2, page 197, paragraphs 2-4)"

As pointed out above, combining two images produced by the Carlson sensor results in high resolution regions followed by low resolution regions. Combining two images in the Huang system results in left and right images which give a stereo effect.

"The stereo images are taken with two digital cameras mounted on a rotational tripod."(Huang, Page 197, Sect. 3.1, 1st Par., lines 2-4).

Thus neither Huang nor Carlson use image sensors which inherently correct for perspective distortion. As pointed out above, Hsieh corrects for perspective distortion through warping software in a digital processor. Clearly, the rejected claims are novel and nonobvious over the cited references and should be allowed.

Summary

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants' attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,



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